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NASA TECH BRIEF

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Wide-Angle Sun Sensors

The problem:

Currently-used Sun sensors have limited fields of view, on the order of less than ±3° on each axis, and are subject to cross-axis coupling. They do not have sufficient redundancy to ensure high reliability. Extra components, such as shadow bars, imaging lenses, or slits, have to be used to produce unequal illumination for detector pairs to generate error signals.

The solution:

New wide-angle Sun sensors have sufficient redundancy and do not need extra components to provide unequal illumination.

How it's done:

Two wide-angle Sun sensors have been developed: one, a single-axis device, is cylindrical; the other, a two-axis device, is spherical. A photosensitive material such as cadmium sulfide is deposited on the sensor surfaces. Multiple pairs of these deposits serve as redundancy, ensuring high reliability. Because of the round surfaces, unequal illumination is easily obtained. When light strikes a round surface at an angle, one-half of the surface is fully illuminated, and the other half is in shadow.

The single-axis sensor is illustrated in Figure 1. Photosensitive substrate material is deposited in strips on a cylindrically shaped substrate. Several pairs of these parallel strips are deposited on adjacent circumferences. Each pair of strips may act as a single-axis detector. The additional pairs are provided for redundancy.

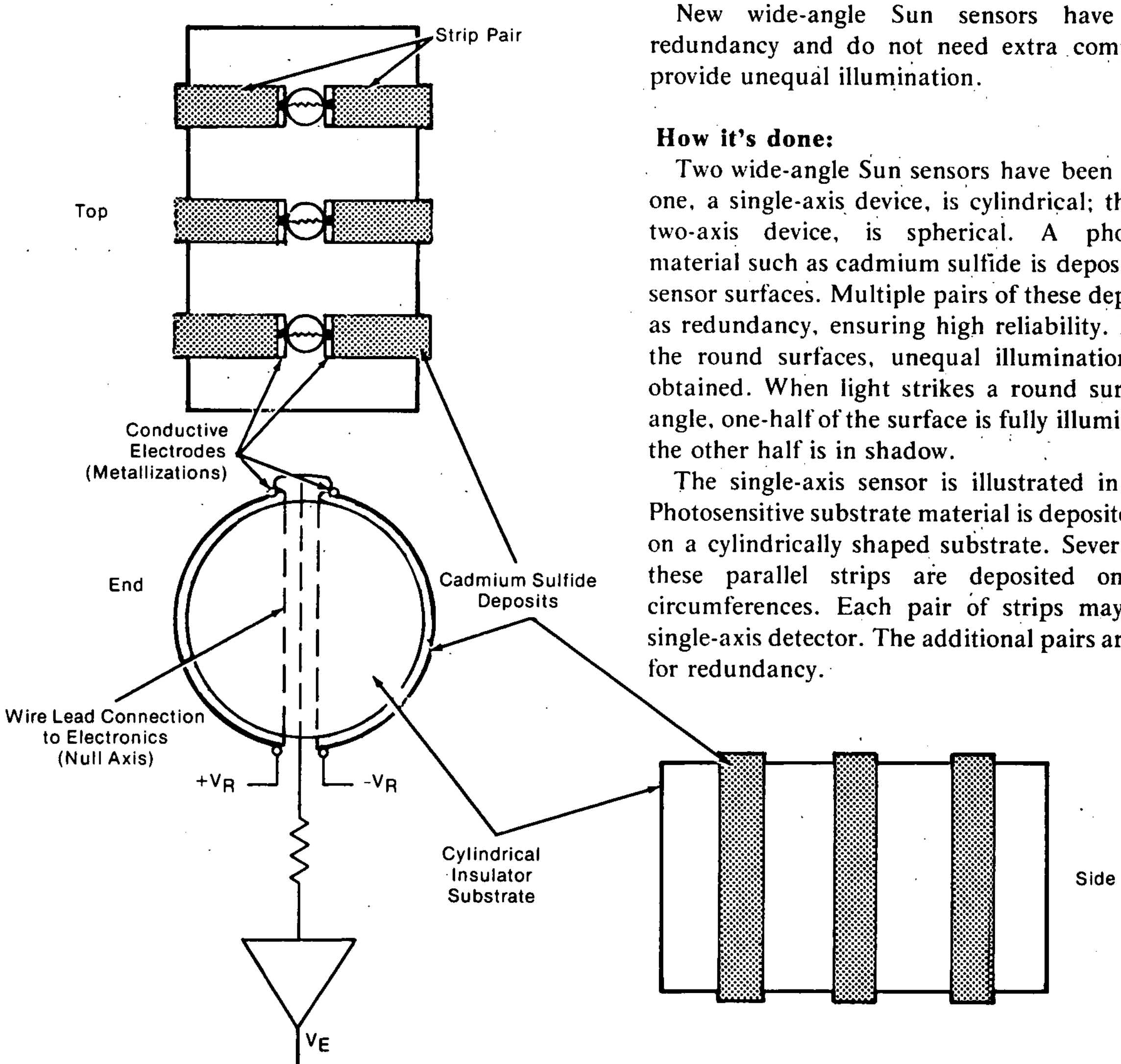

Figure 1. Single-Axis Sun Sensor

(continued overleaf)

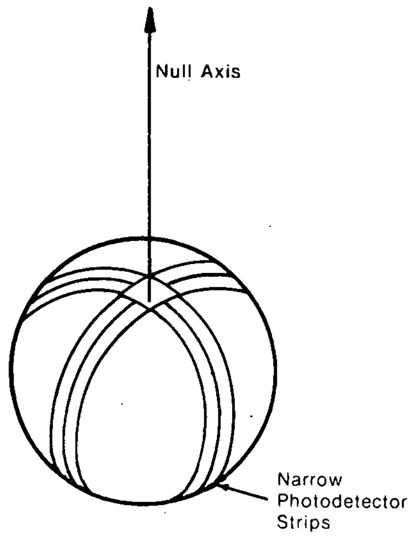

Figure 2. Two-Axis Sun Sensor

Ohmic contacts are made by deposited metallizations at the ends of each strip. Adjacent ends of the strips are joined together with a common ohmic contact. At that point a wire lead is used; it passes through the substrate for connection to the electronics. Metallizations at the other ends of each pair of strips connect respectively with the negative and positive battery voltages (V_R's). The Sun null axis with respect to the device lies in a plane which bisects the cylindrical substrate. It contains the cylinder axis and the common ohmic contact point where the wire lead is attached.

The error signal from this sensor is obtained as follows: When light strikes the sensor surface at an angle displaced from the null axis, one side of the device becomes illuminated, and the other side remains dark. The electrical resistances of the illuminated strips drop. The error signal V_E is determined from the following relationship:

$$V_E = \frac{V_R(R_1 - R_2)}{R_1 + R_2}$$

where V_R is the fixed voltage provided by the battery, and R_1 and R_2 are the resistances of the detector strips. Linear response is obtained over ±50°.

A two-axis spherical configuration is constructed on the same principle. Two sets of narrow photodetector strips divide the spherical substrate into four segments as shown in Figure 2. The null axis is formed at the intersection of the strips. Two error signals are obtained following the same relationship as that for the single axis, except that the coverage is ±50° along each axis.

Note:

Requests for further information may be directed to:

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Reference: TSP75-10202

Patent status:

This invention has been patented by NASA. (U.S. Patent No. 3,875,404). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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Categories: 03 (Physical Sciences)
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